71 SERIES
OSCILLOSCOPE
Y AMPLIFIER 1Y2

DYNAMCO

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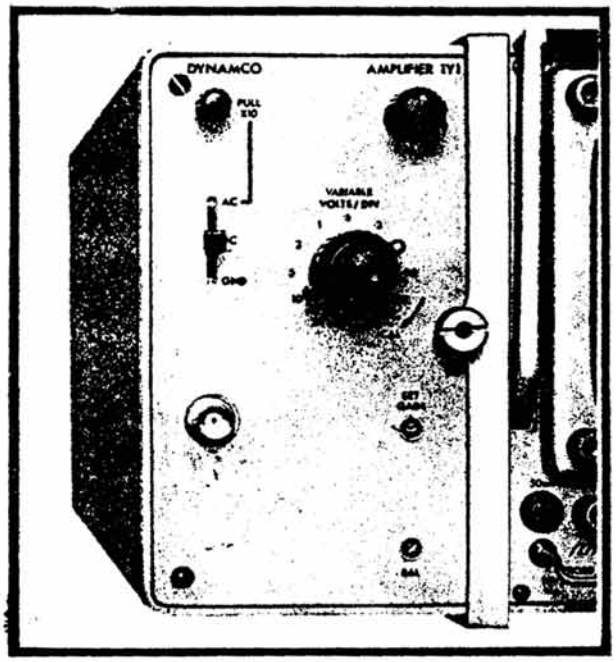
1Y1/2/7

PLUG-ON DEFLECTION MODULES FOR 71 RANGE OSCILLOSCOPES

Performance characteristics are for the modules when used with Type 7100 Display Unit. For performance with other Display Units, refer to the appropriate Display Unit data sheet.



1Y1 SINGLE CHANNEL AMPLIFIER

The 1Y1 is a wide band, single channel amplifier. It has a basic deflection factor of 10mV/division at full bandwidth and a maximum deflection factor of 1mV/division with a switched X10 a.c. coupled preamplifier.

A balanced helical wound delay line provides 160ns of signal delay and the amplifier is factory adjusted for optimum pulse response.

Frequency Response
DC to >30MHz –3dB.
3Hz to >30MHz –3dB a.c. coupled.

Rise Time <12ns.

Mean Disturbances
<2%, amplifier adjusted for optimum pulse response.

Deflection Factors
10mV/division to 20V/division in 11 calibrated ranges. Switched X10 gain provides 1mV/division (response 10Hz-5MHz). Variable control permits continuous uncalibrated adjustment from 1mV/division to 50V/division.

Attenuator Accuracy
3% at 1KHz.

Input
Voltage: 300V d.c. + peak a.c.
Conditions: Switched-'AC', 'DC', 'Ground'.
RC: 1M Ω shunted by 35pF.

Shift
Greater than 2 display windows.

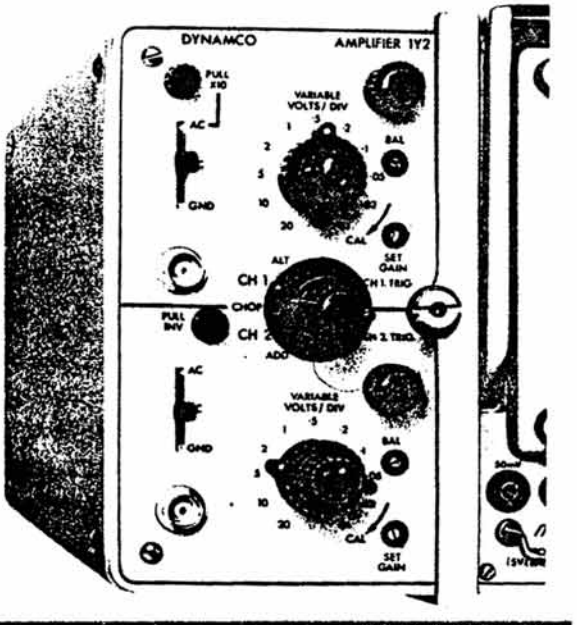
Signal Delay
Approximately 160ns. Balanced, helical wound line.

Horizontal Deflection
When the 1Y1 or 1Y2 is used for horizontal deflection, the deflection factors remain the same and the frequency response is nominally DC to 4MHz –3dB.

Weight
5·5 lb (2·5Kg).

1Y2 DUAL CHANNEL AMPLIFIER

The 1Y2 is a wide band, dual channel amplifier. It features two identical wide-band preamplifiers, each with its own input selector and attenuator, which may be electronically switched to provide single or dual trace displays. In addition the two channels may be combined algebraically.



A balanced helical wound delay line provides 160ns of signal delay and the amplifiers are factory adjusted for optimum pulse response.

The 1Y2 is a dual channel version of the 1Y1. The specifications on each channel are identical to the 1Y1 except for the following additional facilities.

Operating Mode Switch
This switch selects the following functions:
(A) 'Channel 1 only'.
(B) 'Channel 2 only' (normal or inverted).
(C) 'Alternate sweeps'. The timebase generator switches the channels at the end of each sweep.
(D) 'Chopped'. A multivibrator free running at approximately 100KHz, switches the channels.
(E) Added algebraically (Channel 1 ± Channel 2). C.M R.R. >20:1. Max. C.M. input 12cm.

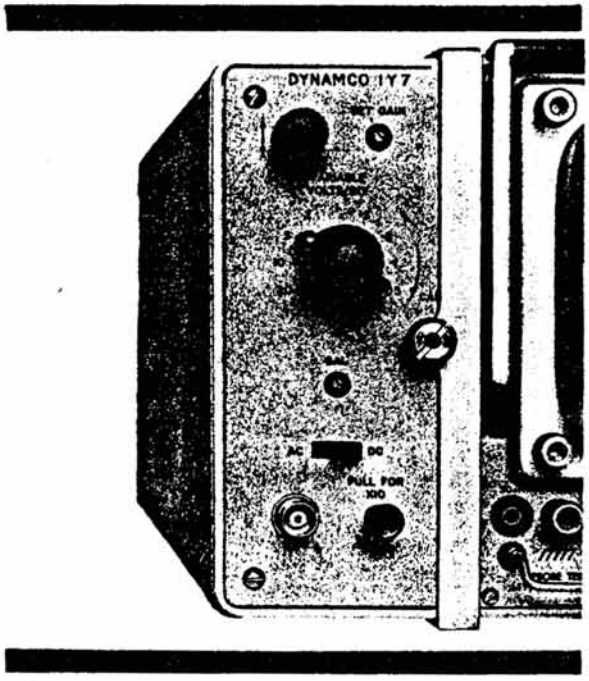
Trigger Source Selector
Switched. 'Channel 1' only or 'Channel 2' only. Mixed trigger may be effected by externally triggering the timebase from the DISPLAY OUT sockets at the rear of the Y amplifier.

Deflection Factors
Identical with 1Y1 except that the switched X10 gain is on Channel 1 only.

Weight
6·65 lb (3Kg).

1Y7 SINGLE CHANNEL AMPLIFIER

The 1Y7 is a general purpose single channel amplifier. It has a basic deflection factor of 50mV/division at full bandwidth and a maximum deflection factor of 5mV/division with a switched X10 a.c. coupled pre-amplifier.



The 1Y7 is only 2¾ in. (7cm) wide and provides an adequate overall performance for most general purpose applications. When used together with the 1X6 Timebase module, provides a minimal size oscilloscope particularly suitable for many field applications.

Frequency Response
DC to >15MHz –3dB.
5Hz to >15MHz –3dB, a.c. coupled.

Rise Time
<23ns.

Mean Disturbances
<2%, amplifier adjusted for optimum pulse response.

Deflection Factors
50mV/division to 20V/division in 9 calibrated ranges. Switched X10 gain provides 5mV/division (response 5Hz-5MHz). Variable control permits continuous uncalibrated adjustment from 5mV/division to 50V/division.

Attenuator Accuracy
3% at 1KHz.

Input
Voltage: 400V d.c. + peak a.c.
Conditions: Switched 'AC', 'DC'.
R.C.: 1M Ω shunted by 30pF.

Shift
Greater than 2 display windows.

Weight
4 lb (1·82Kg).

Horizontal Deflection
When the 1Y7 module is used for horizontal deflection, the deflection factor remains the same and the frequency response is nominally DC to 4MHz –3dB.

1X1 TIMEBASE MODULE

The type 1X1 Module is a wide range timebase with comprehensive triggering facilities, a calibrated X10 magnifier and a single shot mode.

Calibrated Sweep Rates
0·2μs/division to 2secs/division in 22 calibrated steps (1, 2, 5 sequence). A fine control provides continuous uncalibrated variation between steps and extends the range to 5secs/division (50 second sweep).
Accuracy: 5% on all calibrated ranges (including X10 magnifier).

Trigger

Modes:	(A) Triggered
	(B) Auto (timebase free runs in absence of trigger signal).
	(C) Sync.
Source	(A) Internal.
	(B) External.
	(C) External ÷ 20
	(D) Line (via rear socket).
Coupling	(A) AC.
	(B) ACF (AC fast).
	(C) DC external.
Slope	Positive, negative.
Level	(A) Internal, adjustable through ±3 division.
	(B) External, ±1·5V.
	(C) External ÷20, ±30V.
Sensitivity	(A) Internal, 0·2 division.
	(B) External, 100mV.
	(C) External ÷20, 2V.

Trigger Input RC
1M Ω shunted by 30pF.

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1. INTRODUCTION

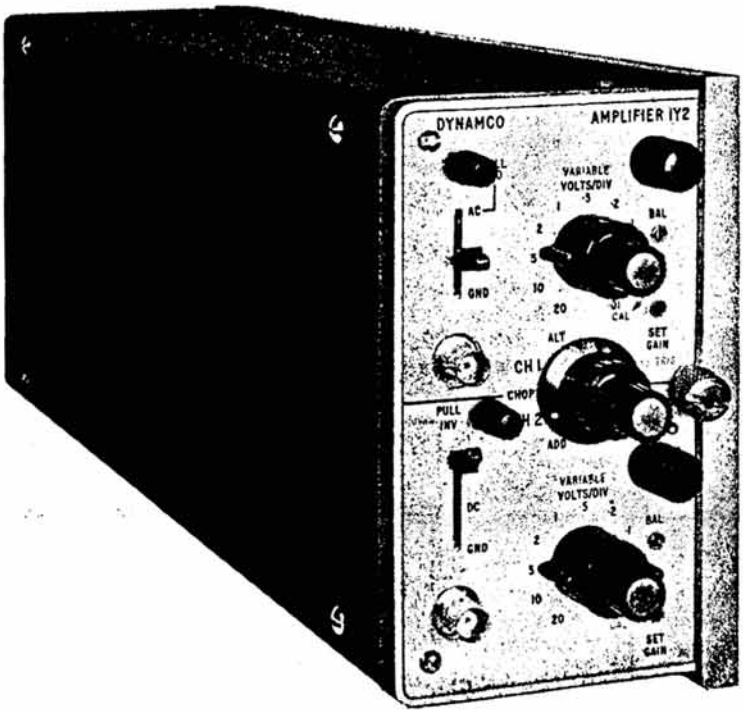


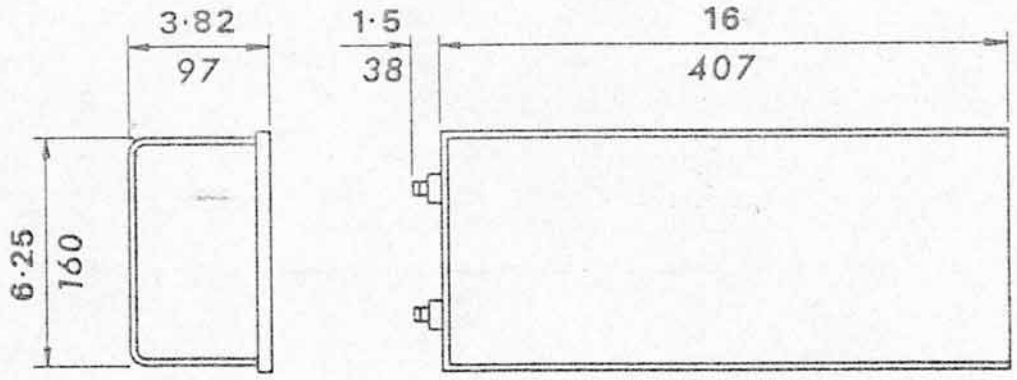
Fig. 1. Dual Channel Amplifier 1Y2

The dual channel amplifier 1Y2 is a wide band (d.c. to 30MHz at 10 millivolts per division) Y-amplifier module designed for use with Dynamco 71 series oscilloscope display units.

The module features two identical wide band pre-amplifiers, each with its own input condition selector and attenuator. The two inputs are switched by a beamswitch to provide single trace, dual trace or algebraically summed displays. Each channel has a basic deflection factor of 10 millivolts per division, and a X-9 a.c. coupled pre-amplifier may be switched into channel 1 giving a maximum deflection factor of 1 millivolt per division. Input signals on channel 2 may be inverted. A balanced helical wound delay line provides a signal delay of 180 nanoseconds. The amplifiers are adjusted for optimum pulse response during manufacture.

The module is of "plug-on" construction; it slides on to the side of the display unit (normally the left-hand side) and is secured in position by a single finger screw. Apart from those mounted on the front panel switches, the components are mounted on glass printed circuit boards marked with component and connected tag identification. Transistors plug in for "out of circuit" checking.

An operating instruction booklet giving condensed details of operation and specification of all 71 series modules is located in a pocket beneath the display unit.



Weight 6·625lb 3·0kg

Dimensions in Inches

Dimensions in Millimetres

FIG. 2 DUAL CHANNEL AMPLIFIER 1Y2 - DIMENSIONS

2. SPECIFICATION

NOTE: The performance figures quoted are for each channel when used for vertical deflection with display unit 7100, unless otherwise stated.

FREQUENCY RESPONSE	D.C. to 30MHz -3dB. 3Hz to 30MHz -3dB (a.c. coupled).
RISE TIME	Not greater than 12ns, with amplifiers adjusted for optimum pulse response.
DEFLECTION FACTOR	10mV/division to 20V/division in 11 calibrated steps (1, 2, 5 sequence). A fine control gives continuous uncalibrated variation between steps and extends the range to 50V/division. NOTE: When the 1Y2 is used for horizontal deflection the deflection factor remains the same but the frequency response is nominally d.c. to 50MHz -3dB.
TRACE EXPANSION	Switched X10, channel 1 only, extending the sensitivity to 1mV/division (frequency response 10Hz to 5MHz).
ACCURACY	±3% on all calibrated ranges (including X10) at 1KHz.
OPERATING MODES	1. Channel 1 only. 2. Channel 2 only (normal or inverted). 3. Alternate: a signal from the timebase generator in the X module switches the channels at the end of each sweep. 4. Chop: the channels are switched by an astable at about 100KHz. 5. Add: channel 1 ± channel 2. When used as a difference amplifier (channel 1 - channel 2) the signal applied to each channel should not exceed 60mV on the 10mV/div. range and pro. rata.
INPUT	Max. voltage: 300V d.c. + peak a.c. Condition: switched a.c., d.c. or ground. Impedance: 1MΩ in parallel with 30pF.
TRIGGER SOURCE	Switched channel 1 or channel 2. DISPLAY OUT socket on back panel gives 100mV/output per division of display (source impedance 1KΩ) which can be connecte to X-module EXT TRIG input to provide a mixed trigger.
SIGNAL DELAY	Approx. 180ns. Balanced helical wound line.
SHIFT	Greater than 2 display windows.
DRIFT	After 1 hour, typically less than 1 div./hr.
MEAN DISTURBANCES	±2%.
HUM AND NOISE	Less than 0.2 divisions peak-to-peak.

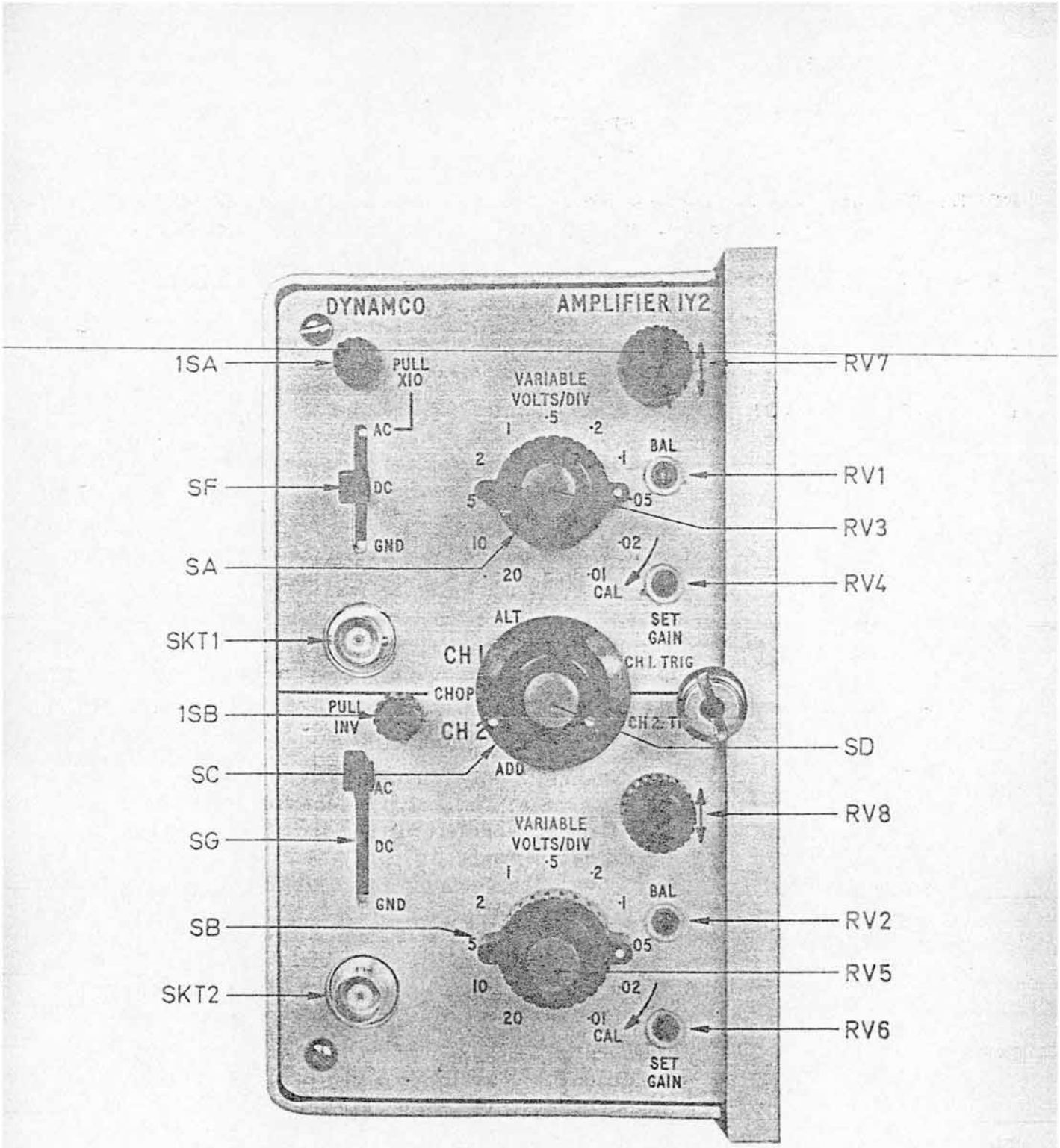


FIG.3 DUAL CHANNEL AMPLIFIER 1Y2 - CONTROLS

3. OPERATING INSTRUCTIONS

3.1 CONTROL FUNCTIONS

Figure 3 shows the location of the front panel controls, and details of their functions are given in Table 1. Those controls marked with an asterisk are duplicated, there being one for each channel.

TABLE 1. CONTROL FUNCTIONS

CONTROL	FUNCTION
VOLTS/DIV*	An 11-position rotary switch which selects the deflection factor. The calibrated sensitivity is obtained only with the VARIABLE control, mounted co-axially with the switch, in the fully clockwise position.
VARIABLE*	A control, coloured red and mounted co-axially with the VOLTS/DIV switch, which provides continuous uncalibrated variation of sensitivity between the steps of that switch and extends the 20V/division range to at least 50V/division.
AC/DC/GND*	A three-position switch which selects a.c. or d.c. signal coupling. In the GND position, the Y amplifier input is grounded and the input socket disconnected.
BAL*	A preset control which balances the amplifier to give minimum trace shift when the sensitivity is varied.
SET GAIN*	A preset control used to adjust the amplifier gain during calibration.
↕ *	This symbol identifies the Y-shift control.
PULL X10	A two-position switch, actually mounted internally, but operated by a rod from the front panel, which increases the gain by a factor of 10, extending the sensitivity of the amplifier to 1mV/division over a bandwidth of 10Hz to 5MHz. The AC/DC/GND switch should be set to AC when the X10 mode is used. (Channel 1 only).
PULL INV	A two-position switch, actually mounted internally but operated by a rod from the front panel which inverts the trace on channel 2.

Table 1 (Cont'd.)

CONTROL	FUNCTION
Y Mode	A five-position rotary switch which selects the required operating mode from the following:- 1. CH1 : Channel 1 only. 2. CH2 : Channel 2 only. 3. ALT : Alternate channel 1/channel 2 sweeps. 4. CHOP : Switched between CH1 and CH2 at approx. 100KHz. 5. ADD : Channel 1 + channel 2 (channel 1 - channel 2 if channel 2 is inverted).
Trigger source	A two-position switch, coloured red and mounted co-axially with the Y mode switch which selects either channel 1 or channel 2 as the trigger source.

3.2 OPERATION

The following instructions assume that the Y-amplifier module is fitted to a display unit and timebase module which are correctly calibrated

Initial Calibration

Calibration is necessary when a new or replacement amplifier module is fitted, or after replacement of a faulty component. Proceed as follows:-

(1) On the display unit, set the BRILL, FOCUS and ASTIG controls to their midway positions.

(2) On the timebase module set the controls, where applicable, as follows:-

Trigger source	:	INT
Trigger coupling	:	AC
Slope	:	+
LEVEL	:	Midway (1X1, 1X2) AUTO (1X6)
HF STAB	:	AUTO (1X1, 1X2)
TIME/DIV (A)	:	1mS
VAR	:	CAL
PULL X10	:	in
DISPLAY	:	NORMAL (1X1) A SWEEP (1X2)

(3) On the Y-amplifier module 1Y2, set the controls as follows:-

CH1	(	VOLTS/DIV	: .01
	(	VARIABLE	: CAL (fully clockwise)
	(	AC/DC/GND	: AC
	(	Shift	: midway

PULL X10	:	in
Mode	:	CH1
Trigger source	:	CH1 TRIG

(4) Connect a short screened jumper lead between the 50mV calibrator output socket on the display unit and the channel 1 input socket on the Y module.

(5) Switch on with the GRAT control on the display unit and check that the red supply lamp glows ; further adjust the GRAT control to set the graticule brightness as required. Adjust the BRILL, FOCUS and ASTIG controls to give the best trace. Allow at least 15 minutes warm-up time.

(6) Set the CH1 AC/DC/GND switch to GND. Rotate the VARIABLE control over its full range and verify that no trace shift occurs. If necessary adjust the channel 1 BAL control for minimum trace shift. Return the VARIABLE control to CAL, and set the AC/DC/GND switch to AC.

(7) Verify that the trace occupies exactly 5 divisions on the graticule. If necessary adjust the channel 1 SET GAIN control for 5 divisions peak to peak.

(8) Connect the input to channel 2 input socket. Set the mode switch to CH2 and the trigger source switch to CH2 TRIG. Repeat (6) and (7) for channel 2.

THE OSCILLOSCOPE IS NOW CALIBRATED AND READY FOR SERVICE.

Single Trace Operation

(1) Connect the input signal to either channel 1 or channel 2 input socket and set the mode and trigger source switches appropriately.

(2) Set the AC/DC/GND switch for the selected channel to AC or DC as required, and set the VOLTS/DIV switch for the selected channel for the sensitivity required. Ensure that the red VARIABLE control is set to CAL (fully clockwise) to obtain the calbrated sensitivity.

(3) Set the shift control on the selected channel to display the signal.

(4) The PULL X10 control provides X10 gain on channel 1. The d.c. component of the applied signal is not amplified. For best results when using the X10 facility, the AC/DC/GND switch should be set to AC.

Dual Trace Operation

(1) Connect the input signals to the channel 1 and channel 2 input sockets. Set the AC/DC/GND and VOLTS/DIV switches for each channel as described for single trace operation.

(2) Set the trigger source switch to CH1 TRIG or CH2 TRIG as required, and set the mode switch to either CHOP or ALT. CHOP is normally selected for low sweep speeds, i.e. below 1mS/division, and ALT for higher sweep speeds. The bandwidth of the trigger amplifier is reduced in CHOP.

NOTE: It is possible to display channel 1 only, but to lock to signals applied to channel 2 input by setting the mode switch to CH1 and the trigger source switch to CH2 TRIG (or vice versa of course).

Mixed Trigger Operation

This mode of operation may be used if signals are not synchronous. The trigger is taken off after beam switching and signal delay. Proceed as follows:-

(1) Set the mode switch to ALT. Connect the DISPLAY OUT and EARTH sockets on the back panel of the Y module to the EXT TRIG socket on the front panel of the X module.

(2) Set the X module trigger source switch to EXT and adjust the LEVEL control to give a stable display. (Signals greater than 1cm are required). The sweep is now triggering from the displayed signal.

Algebraic Addition of Input Signals

(1) Display each signal on its appropriate channel as described above.

(2) Set the Y mode switch to ADD. The resulting display is the algebraic sum of channel 1 and channel 2 signals.

(3) To display the difference of channel 1 and channel 2 signals, pull the PULL INV control.

(4) The common mode rejection ratio should not be worse than 20 : 1 under any circumstances, but where it is important to achieve maximum c.m.r.r. proceed as follows.

(5) Set the VOLTS/DIV switch on each channel to the required range. Apply a signal via a T connector to both channel 1 and channel 2 input sockets (do not exceed the maximum signal for the range selected).

(6) Set the MODE switch to ADD, and pull the PULL INV control.

(7) Adjust the VARIABLE control for one channel to obtain the best straight line. If the adjustment results in a worse straight line, return the control to CAL and adjust the VARIABLE control for the other channel. The best c.m.r.r. is now achieved.

NOTE: At h.f. (say, greater than 100KHz) equal lengths of cable from T-connector to input are vital. If probes are to be used they must be connected to the channel input and fed from the common signal source when adjusting for maximum c.m.r.r. The probes must then be retained on the respective channel inputs.

3.3 INTERCONNECTIONS

Interconnections are made via two 12-pole fixed plugs PLC and PLD (Fig. 4) which mate with fixed sockets SKTC and SKTD on the display unit. Connections to PLC and PLD are listed in Tables 2 and 3 (overleaf).

Signal inputs are connected to the co-axial connectors SKT1 (channel 1) and SKT2 (channel 2) on the front panel (Fig. 3) and a signal output is available at the 2mm socket SKT3 DISPLAY OUT on the back panel (Fig. 4). This output is taken after beam switching and signal delay and may be connected to the X-module EXT TRIG input for mixed trigger operation. An earth point is made available at SKT4 on the panel.

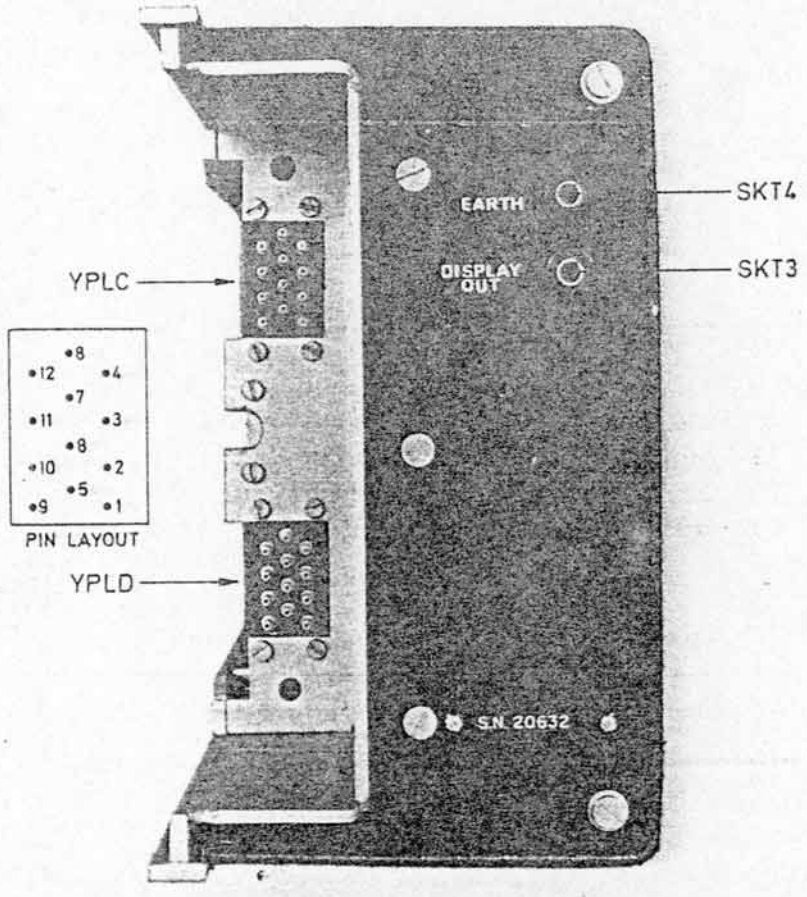


Fig. 4. Dual Channel Amplifier 1Y2 - Rear View

TABLE 2. CONNECTIONS TO PLC

PIN	FUNCTION	REMARKS
1	Amplifier Input +)	(
2	Earth)	(100mV/cm
3	Amplifier Input -)	(
4	Bright-up Command - Live	7.5mA negative
5	Alternate Gate	
6	Earth	
7	Not used	
8	Bright-up Command - Earth	
9 to 12	Not used	

TABLE 3. CONNECTIONS TO PLD

PIN	FUNCTION	CURRENT
1	+117V	12mA
2 to 4	Not used	
5	+15V	313mA
6	0V	
7, 8	Not used	
9	-15V	200mA
10	Trigger +	
11	Earth	
12	Trigger -	

4. TECHNICAL DESCRIPTION

4.1 FUNCTIONAL DESCRIPTION (Fig. 5)

Signals applied to the channel 1 and channel 2 input sockets are fed via switched attenuators and amplifiers to inhibit gates G1 and G2 controlled by the output of an astable in the beam switching circuit. The channel 1 signal may be switched through a X(-9) amplifier to give an overall increase in gain of X10, and the channel 2 signal may be inverted. The beam switch provides the following modes of operation:-

1. Channel 1 only (CH1)
2. Channel 2 only (CH2)
3. Alternate channel 1/channel 2 sweeps (ALT)
4. Chopped between channels at 100KHz (CHOP)
5. Algebraic addition of channels (ADD)

When CH1 is selected the beam switch astable is set so that G1 is open and G2 is inhibited, and only channel 1 signals can pass. With CH2 selected, the situation is reversed, and channel 2 signals are displayed. When ALT is selected, the beam switch, now connected as a bistable is triggered at the end of each sweep by a gate signal from the X-module. Channel 1 and channel 2 signals are therefore displayed on alternate sweeps. In the CHOP mode the beam switch is connected as an astable, and G1 and G2 changeover alternately at about 100KHz. At each change of state a pulse is routed via a shaper to the bright-up amplifier in the display unit. This pulse is used to blank the display while the astable changes over. When ADD is selected, the astable is turned off and the inhibit is removed from both G1 and G2, allowing both signals to pass.

The signals selected by the beam switch are fed via a balanced helical delay line and an output paraphase amplifier to the Display Unit, where after a final stage of amplification they are applied to the c.r.t. Y plates. The delay line enables the leading edges of fast pulses to be displayed without requiring a trigger pre-pulse.

Signals from either channel may be selected by the switch SD and fed via an amplifier to the trigger circuits in the X module. A mixed trigger may be obtained from the output stage for synchronous signals.

4.2 CIRCUIT DESCRIPTION (Fig. 8)

NOTE: In the circuit diagram (Fig. 8) the prefix "1" identifies components mounted on the main printed circuit board. Components on the trigger amplifier board are prefixed "2".

Channel 1 Amplifier

The channel 1 input at SKT1 is applied via the input selector switch SF (AC/DC/GND), shown in the AC position, to a frequency compensated cascade attenuator giving ÷ 2 to ÷ 2000 attenuation selected by switch SA (VOLTS/DIV). Cathode follower 1V1 is used in the input circuit to obtain an input impedance of one megohm. Resistor R14 and neon 1LP1 protect the valve from excessive positive and negative input voltages. Diode 1D15 protects the emitter follower 1VT1 which is fed from the cathode of 1V1. The decoupling components 1R2 and 1C1 also act as frequency compensation for the stage. Emitter follower 1VT1 feeds the base of 1VT4 and X9 a.c. coupled amplifier 1VT2 via switch 1SA (PULL X10 AC), which selects either X1 or X10 operation. In the X1 position, feedback via capacitor 1C37 holds the a.c. gain of the circuit down to unity. In the X10 position the gain from the input of 1VT2 to the base of 1VT3 is -9 and this amplified signal is applied via emitter follower 1VT3 to the base of 1VT5. Balance controls 1RV2 (coarse) and RV1 (fine, BAL) produce a summed voltage at the base of emitter follower 1VT3 which provides a low impedance source for 1VT5.

1VT4 and 1VT5 are connected as a long tailed pair differential amplifier. In the X10 position of 1SA the signals appearing at the bases of 1VT4 and 1VT5 have gains of 1 and -9 with respect to 1VT1 emitter, giving an overall increase in gain of 10 between these points. RV7 is the trace SHIFT control and the gain of the stage is variable over a ratio of $2\frac{1}{2}$: 1 by the VARIABLE control RV3. RV4 is the SET GAIN control.

The outputs are fed to a second long-tailed pair 1VT6 and 1VT7 connected in the emitter circuit by h.f. compensating components. The diode gate 1D1, 1D2, 1D3 and 1D4 in the collector circuit of the amplifier is operated by the beamswitch circuit 1VT15, 1VT16 which is controlled by the mode switch SC.

Channel 2 Amplifier

Channel 2 amplifier is similar to that for channel 1, differing from it chiefly in that it has no X10 facility, but includes a switch 1SB which can be used to invert the channel 2 signal. The preset 1RV4 in the common emitter circuit of the long tailed pair 1VT2, 1VT13 is adjusted to equalize the d.c. conditions in the two channels.

Beam Switch

The beam switch circuit 1VT15, 1VT16 can operate in five modes, any one of which is selected by the mode switch SC.

In the ALT position of SC, the circuit is biased to function as a bistable which is triggered by the alternate gate waveform from the X-module at YPLC/5. This waveform is fed via pin 46 and the differentiating circuit 1C13, 1R55 to 1VT14 base. The negative going pulses from 1VT14 are fed to the diodes 1D11, 1D12 and cause the bistable to change state in step with the timebase waveform. When 1VT16 is conducting, 1VT15 is turned off and the potential of about -8V at 1VT15 collector appears at the junction of 1D1 and 1D2 in channel 1 diode gate,

causing it to pass the channel 1 signal. With about -3.2V applied to the junction of 1D5 and 1D6, channel 2 gate is closed. This condition is reversed at the end of each timebase sweep.

With CH1 selected, +15V is applied via SC and 1R52 to the emitter of 1VT16, switching it hard on and turning off 1VT15. Channel 1 diode gate is therefore open and channel 2 gate closed, and the channel 1 signal passes through. When SC is set to CH2, 1VT15 is switched hard on and the circuit conditions are reversed.

With CHOP selected, the circuit free-runs at about 100KHz, so that the display is chopped between channel 1 and channel 2 signals at this frequency. To blank the display as the circuit changes state a pulse derived from the waveforms at the emitters of 1VT15 and 1VT16, shaped by 1VT17 and 1D17, is routed to the bright-up amplifier in the display unit. A bias voltage is applied via SC, 1R13 and 2R11 to 2D1 on the trigger amplifier board. The diode conducts, connecting the collectors of 2VT1 and 2VT2 by 2C3 and 2C4. This reduces the bandwidth of the trigger amplifier, thus preventing break through of the chop waveform on to the trigger waveform.

When SC is set to ADD, the +15V supply is removed from the astable, which is therefore switched off, and applied to the junction of 1R84 and 1R85. Both diode gates are therefore open and the signals from both channels are fed to the output amplifier.

A reference voltage for the beam switch circuit, adjusted by 1RV9, is applied via 1VT18 to the junction of 1R62, 1R63.

Delay Line

The signals from the diode gates are routed to the balanced helical wound line which imposes 180ns of signal delay. 1R86 and 1R87 are matching resistors and 1D9 and 1D10 are clipping diodes. The delay line is matched into the output stage by a frequency compensated network adjusted by 1RV10, 1RV11 and 1C19.

Output Amplifier

1VT21 and 1VT22 are connected as a long tailed pair in which each transistor is a virtual earth feedback amplifier. The paraphase outputs are fed via emitter followers 1VT19 and 1VT20 and YPLC/1 and 3 to the display unit. 1RV9 is adjusted to set the mean output d.c. levels to 0V.

Trigger Amplifier

The trigger amplifier 2VT1, 2VT2 is a further long tailed pair. The trigger source switch SD selects either channel 1 or channel 2 inputs to the amplifier; the inputs are buffered by the emitter followers 1VT23 to 1VT26. 2RV1 balances the amplifier and 2RV2 sets the d.c. level at the outputs, which are routed via YPLD/10 and YPLD/12 to the X-module. 2C3 and 2C4

reduce the amplifier bandwidth in the CHOP mode (see beam switch description).

Power Supplies

All power supplies for the module are obtained from the display unit. The supplies to certain stages are separately decoupled within the module. The heater supply for 1V1 and 1V2 is derived from the +15V input by 1R88 and 1C36.

5. MAINTENANCE

5.1 MECHANICAL FEATURES

Removal of Module from Display Unit

Unscrew the slotted thumbscrew on the front and give the module a sharp pull forwards with the left hand while holding the display unit with the right. This will disengage the connectors, and the module will then slide smoothly off in a forwards direction. To replace the module, engage the rails on the frame with the guides on the chassis and slide the module on until the retaining screw engages, then tighten the screw.

Removal of Cover

The module cover may be removed by unscrewing the four plated screws on the outer face of the cover.

Access to Chassis Components

Access to components mounted on the chassis e.g. attenuator components, may be facilitated by removing the front panel assembly from the chassis. Disassembly and assembly is self-evident.

Access to Amplifier Board

Access to certain components on the amplifier board is facilitated by removing the delay line assembly from the chassis. Proceed as follows:-

(1) Unplug delay line Amp connectors from the amplifier board (18, 19, 22, 24).

(2) Remove four screws securing the delay line assembly to the horizontal chassis members.

(3) Remove delay line assembly.

(4) Assembly is the reverse procedure to removal.

Amp Connectors

On some units connections to the circuit boards are made via Amp type pin connectors. It is essential when removing or inserting these connectors that the following precautions are observed:-

(1) Remove Amp pins by firmly grasping the crimped portion of the socket with a pair of square nosed or duck billed pliers and pulling the socket with an even pressure along the axis of the pin.

(2) Fit Amp pins by firmly grasping the crimped portion of the socket with a pair of square nosed or duck billed pliers and pushing the socket squarely on to the pin with even pressure.

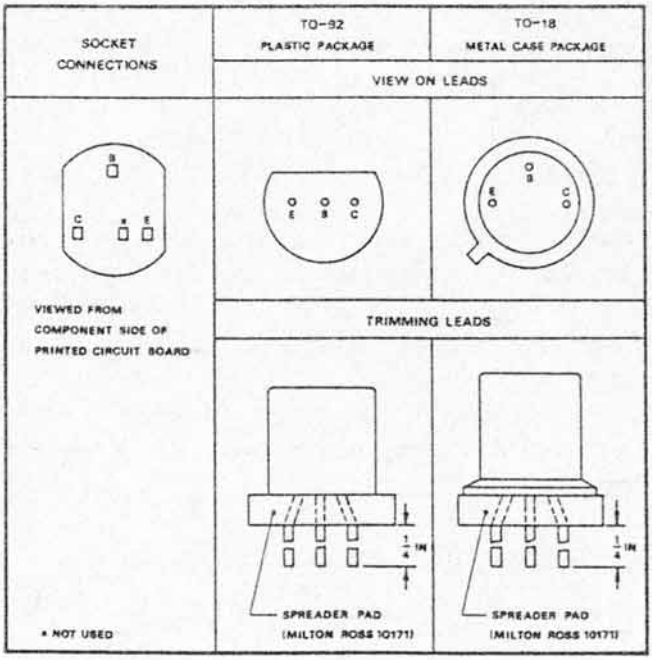
(3) Making 'unsquare' connections can tend to open out the socket and result in a poor connection. This may cause intermittent operation of the instrument.

(4) Any reconnections showing signs of looseness must be remade after the socket has been sufficiently closed up.

Plug-in Semiconductors

All transistors are of the plug-in type. When renewing such components the leads must be trimmed as specified in Table 4.

TABLE 4. PLUG-IN SEMICONDUCTOR INFORMATION



5.2 TEST PROCEDURE

All internal potentiometers are set up at the factory, and should not be disturbed unless components are replaced or there is a definite indication that the module is functioning incorrectly. Should this be the case the relevant potentiometer(s) should be set to the mid-position and then reset according to

the following instructions. If all sections are completed, the module will have been fully tested to specification. Individual checks, may of course, be performed if required.

Equipment Required

1. Multimeter e.g. AVO 8.
2. Calibrated Dynamco 71 series X-module.
3. Calibrated Dynamco 71 series display unit.
4. Module to display unit extension leads. (Dynamco 7148).
5. BNC to banana adaptor cable to Dynamco drawing A108 0266.
6. Fast Rise Time Pulse Generator, capable of producing 500mV pulses with risetime not greater than 3ns at frequencies from 100KHz to 1MHz e.g. Cossor 1090.
7. 10 : 1 Attenuator pad, 20dB, 50Ω e.g. Greenpar GE 83013/20.
8. Constant Amplitude Sinewave Generator 50KHz - 100MHz e.g. Tektronix 191.
9. Calibrator capable of providing a 1KHz square wave at amplitudes from 5mV to 5V ± 2%.
   NOTE: If this item is not available, the calibrator circuit in the display unit may be used, although all the amplitudes specified in this procedure will not then be available.
10. Capacitance equaliser pad (see Fig. 6).
11. BNC T-junction e.g. Greenpar GE 35031.

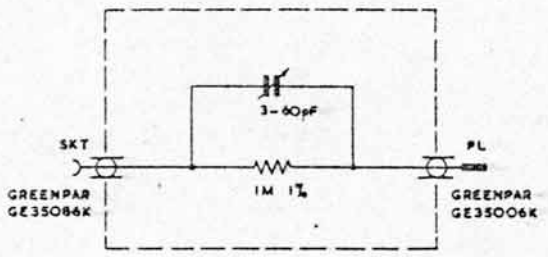


Fig. 6. Capacitance Equaliser Pad

Supplies Check

(1) Connect the multimeter negative lead to the chassis of the module under test and verify that the line resistances are as specified in Table 5.

TABLE 5. SUPPLY RAIL RESISTANCE

RAIL	PIN	RESISTANCE
+117V	YPLD/1	Open circuit
+15V	YPLD/5	Approx. 80Ω
-15V	YPLD/9	Approx. 2KΩ

(2) Plug the X-module on to the display unit and connect the module under test to the display unit using the extension lead (item 4).
Set the front panel controls as follows:-

CH1 & CH2	AC/DC/GND	:	DC
	VOLTS/DIV	:	1
	VARIABLE	:	CAL (fully clockwise)
	SHIFT	:	midway
	BAL	:	midway
	SET GAIN	:	fully counterclockwise
	PULL INV	:	in
	PULL X10	:	in
	Mode	:	CH1
	Trigger source	:	CH1 TRIG

(3) On the X-module set the controls, where applicable, as follows:-

Trigger source	:	INT
Trigger coupling	:	AC
Slope	:	+
LEVEL	:	midway (1X1, 1X2) AUTO (1X6)
HF STAB	:	AUTO (1X1, 1X2)
TIME/DIV	:	1mS
VAR	:	CAL
PULL FOR X10	:	in
DISPLAY	:	NORMAL (1X1) A SWEEP (1X2)

(4) Switch on, allow 15 minutes warm up, and verify that the supply rail voltages are as specified in Table 6.

TABLE 6. SUPPLY RAIL VOLTAGES

MAIN PCB PIN	VOLTAGE
8	+117 ± 3V
29	+15 ± 0.3V
11	-15 ± 0.3V

Channel 1 D.C. Levels

(1) Connect the multimeter set to the 2.5V d.c. range between pin 28 on the main p.c.b. and the emitter of 1VT5 (junction of 1R34, 1R35). Adjust 1RV2 for 0V.

(2) Connect the multimeter between pins 50 and 51 and adjust the SHIFT control for zero volts. Transfer the meter lead from pin 50 to chassis and adjust 1RV9 for 0V.

Trigger Amplifier D.C. Levels

(1) Connect the multimeter between pins 41 and 42 on the trigger board and adjust 2RV1 for 0V.

(2) Set the multimeter to the 10V range, transfer the lead from pin 42 to chassis and adjust 2RV2 for 4.5V.

NOTE: These adjustments interact and it may be necessary to check and re-adjust until the correct voltages are obtained.

Channel 2 D.C. Levels

(1) Set the mode switch to CH2. Connect the multimeter set to the 2.5V d.c. range between pin 6 on the main p.c.b. and the emitter of 1VT11 (junction of 1R46, 1R49) and adjust 1RV3 for 0V.

(2) Connect the multimeter between pins 50 and 51 and adjust the SHIFT control for 0V.

(3) Transfer the multimeter lead from pin 51 to chassis and adjust 1RV4 for 0V.

(4) Re-adjust 1RV2 for channel 1 and 1RV3 for channel 2 so that the trace does not move when the variable gain controls are rotated.

Channel Gain Adjustment

(1) Set the controls on the module under test as follows:-

CH1 & CH2	AC/DC/GND	:	AC
	VOLTS/DIV	:	.01
	VARIABLE	:	CAL (fully clockwise)
	Mode	:	CH2
	Trigger source	:	CH2 TRIG

(2) Connect the 50mV output from the display unit calibrator to the channel 2 input socket, using the adaptor cable (item 5). Adjust the channel 2 SET GAIN control for a 5 division display.

(3) Repeat the adjustment for channel 1.

Delay Line Matching and Pulse Response

(1) Set the mode and trigger source switches to CH1. Check that the channel 1 AC/DC/GND switch is set to AC.

(2) Apply a square wave from the Fast Rise Time Pulse Generator (item 6) to channel 1 input via the pad and lead supplied with the generator and the attenuator (item 7).

(3) Set the controls to display a single cycle four divisions high. Adjust 1C19 for optimum delay line matching i.e. smallest pulse in Fig. 7.

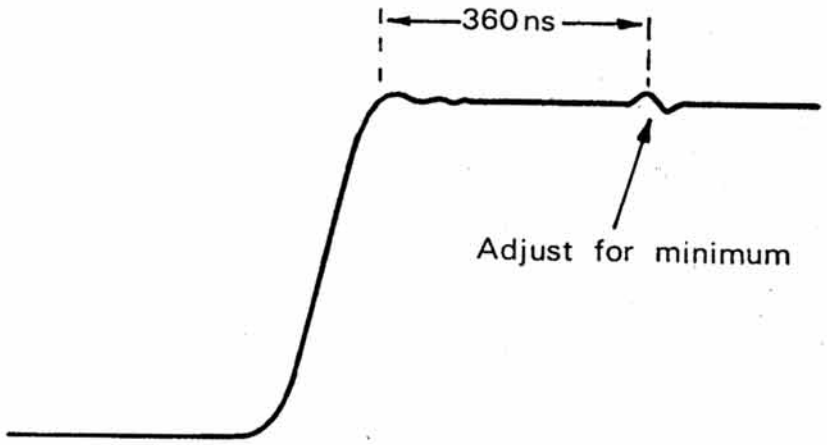


Fig. 7. Optimum Delay Line Matching

(4) Set 1RV5 fully counter-clockwise. Slowly turn 1RV5 clockwise and adjust 1C10 to obtain the best compromise between fast rise time and minimum overshoot on the displayed pulse.

(5) Set the mode trigger source switches to CH2 and connect the signal to channel 2 input. Set 1RV6 fully clockwise. Slowly turn 1RV6 counter-clockwise and adjust 1C11 to obtain the best compromise between fast rise time and minimum overshoot on the displayed pulse.

Bandwidth Check

(1) Check that mode and trigger source switches are set to CH2 and that the channel 2 VOLTS/DIV switch is set to 0.01. Check that the X module TIME/DIV switch is set to 1mS.

(2) Connect a 50KHz signal from the Constant Amplitude Sinewave Generator (item 8) to channel 2 inout and adjust the amplitude for a 5 division display.

(3) Increase the frequency until the display height decreases to 3.5 divisions. Verify that this frequency is not less than 30MHz.

(4) Repeat paras. (1) to (3) for channel 1.

1KHz Pulse Response

(1) Check that the mode and trigger source switches are set to CH1. Connect a 1KHz square wave from the Calibrator (item 9) to channel 1 input. Adjust 1RV7 for the optimum square wave display.

(2) Repeat para. (1) for channel 2.

Input Attenuator Adjustments

(1) Set the mode and trigger source switches to CH1. Connect a 1KHz signal from the Calibrator to channel 1 input. At each position of the VOLTS/DIV switch specified in Table 7, adjust the capacitor specified for optimum square wave display. Repeat for channel 2.

TABLE 7. ATTENUATOR ADJUSTMENT 1.

VOLTS/DIV	Input	Adjust for CH1	Adjust for CH2
.02	100mV	C5	C22
.05	200mV	C7	C24
.1	500mV	C9	C26
.2	1V	C11	C28
.5	2V	C13	C32
1	5V	C2	C19

(2) Connect a 1KHz signal from the Calibrator via the Capacity Equaliser Pad to channel 2 input. Check that the mode and trigger source switches are

set to CH2. At each position of the VOLTS/DIV switch specified in Table 8, adjust the capacitor specified for optimum square wave display. Repeat for channel 1.

TABLE 8. ATTENUATOR ADJUSTMENT 2

VOLTS/DIV	Input	Adjust for CH2	Adjust for CH1
.01	100mV	Capacitor in equaliser pad	
.02	200mV	C23	C6
.05	500mV	C25	C8
.1	1V	C27	C10
.2	2V	C29	C12
.5	5V	C33	C14
1	10V	C20	C3

Attenuator Accuracy Check

(1) Check that the VARIABLE controls are set to CAL. Using inputs from the Calibrator to give nominal 4 or 5 division displays, check the accuracy of the input attenuators for each position of the VOLTS/DIV switch for both channels.

(2) Verify that the picture height is 4 ± 0.12divisions or 5 ± 0.15 divisions.

Channel 1 X10 Gain

(1) Connect a 5mV signal from the Calibrator to channel 1 input. Check that the VOLTS/DIV switch for channel 1 is set to .01 and that the VARIABLE switch is set to CAL (fully clockwise).

(2) Pull out the PULL X10 control and adjust 1RV1 for a 5 division display. Reset the PULL X10 switch to X1.

Trigger Sensitivity

(1) Apply a 0.2 division signal from the Calibrator and check that stable triggering can be obtained from both channels using the LEVEL control on the X-module.

(2) Check for triggering in the correct polarity (i.e. from the positive edge when the X-module slope switch is at +) for both channels.

Mode Switch Checks

(1) Switch both channel inputs to GND, set the mode switch to ALT and check that the VARIABLE controls are set to CAL (fully clockwise).

(2) Verify that a satisfactory display of channel 1 and channel 2 alternately is obtained for all timebase ranges.

(3) Set the mode switch to CHOP, and check that the display is adequately blanked and that the chop frequency is approximately 100KHz (trigger by connecting the DISPLAY OUT socket at the rear of the 1Y2 to the EXT TRIG socket on the front of the X-module).

(4) Set the mode switch to ADD and check that the trace can be moved by both shift controls.

(5) Apply a 20mV signal from the Calibrator via the T junction (item 11) to both inputs and set the VOLTS/DIV switch to .01 and the AC/DC/GND switch to AC on both channels. Verify that the display is 4 divisions high.

(6) Pull the PULL INV control and verify that the square wave can be nulled with the VARIABLE controls. Return the PULL INV control.

Balance Adjustment

(1) With both inputs switched to GND, re-adjust 1RV2 (channel 1) and 1RV3 (channel 2) for zero trace shift when the appropriate VARIABLE control is rotated.

5.3 MAINTENANCE BY DYNAMCO

If an instrument is returned to Dynamco Limited for repair or recalibration, please state clearly what is wrong. Do not return any cable unless it is suspect, in which case please note this on the documents accompanying the instrument, and under no circumstances return any handbooks.

6. PARTS LIST

6.1 GENERAL

The following list includes all replacement parts. When ordering, please quote the TYPE and SERIAL NUMBER of the instrument. together with the CIRCUIT REFERENCE of the part and the relevant SUB-ASSEMBLY.

DMS numbers given for semi-conductor components refer to standards defined by Dynamco Limited to ensure that only those equivalent components are used which enable the specified performance of the instrument to be achieved.

6.2 FRAME COMPONENTS

Circuit Ref.	Value	Tol.	Rating	Type	Style
RESISTORS					
R1 to R3	10	±10%	$\frac{1}{4}$W	Composition	Dubilier B.T.T.
R4	990K	±1%		Spiral carbon	Welwyn C2114
R5	10.1K	±1%		Spiral carbon	Welwyn C2114
R6	1M	±1%		Spiral carbon	Welwyn C2114
R7	800K	±1%		Spiral carbon	Welwyn C2114
R8	250K	±1%		Spiral carbon	Welwyn C2114
R9	900K	±1%		Spiral carbon	Welwyn C2114
R10	111K	±1%		Spiral carbon	Welwyn C2114
R11	52.6K	±1%		Spiral carbon	Welwyn C2114
R12	20.4K	±1%		Spiral carbon	Welwyn C2114
R13	10	±10%	$\frac{1}{4}$W	Composition	Dubilier B.T.T.
R14	100K	±10%	$\frac{1}{4}$W	Composition	Dubilier B.T.T.
R15	1M	±1%		Spiral carbon	Welwyn C2114
R16	100K	±10%	$\frac{1}{4}$W	Composition	Dubilier B.T.T.
R17	1M	±1%		Spiral carbon	Welwyn C2114
R18 to R20	10	±10%	$\frac{1}{4}$W	Composition	Dubilier B.T.T.
R21	990K	±1%		Spiral carbon	Welwyn C2114
R22	10.1K	±1%		Spiral carbon	Welwyn C2114
R23	500K	±1%		Spiral carbon	Welwyn C2114
R24	1M	±1%		Spiral carbon	Welwyn C2114
R25	800K	±1%		Spiral carbon	Welwyn C2114
R26	250K	±1%		Spiral carbon	Welwyn C2114
R27	900K	±1%		Spiral carbon	Welwyn C2114
R28	111K	±1%		Spiral carbon	Welwyn C2114
R29, R30	950K	±1%		Spiral carbon	Welwyn C2114
R31	52.6K	±1%		Spiral carbon	Welwyn C2114
R32, R33	980K	±1%		Spiral carbon	Welwyn C2114
R34	20.4K	±1%		Spiral carbon	Welwyn C2114

Circuit Ref.	Value	Tol.	Rating	Type	Style
R35	500K	±1%		Spiral carbon	Welwyn C2114
R36 to R39	18	±10%	¼W	Composition	Dubilier B.T.T.
R40 to R45	10	±10%	¼W	Composition	Dubilier B.T.T.
R46, R47	56	±10%	¼W	Composition	Dubilier B.T.T.
R48, R49	33	±10%	¼W	Composition	Dubilier B.T.T.
R50, R51	Not used				
R52	10	±10%	¼W	Composition	Dubilier B.T.T.
R53, R54	120	±10%	¼W	Composition	Dubilier B.T.T.
R55	Not used				
R56, R57	470	±10%	¼W	Composition	Dubilier B.T.T.
R58, R59	5.6	±10%	¼W	Composition	Dubilier B.T.T.
VARIABLE RESISTORS					
RV1, RV2	25K			Linear	Morganite U
RV3	500			Linear	Morganite U
RV4	250			Linear	Morganite U
RV5	500			Linear	Morganite U
RV6 to RV8	250			Linear	Morganite U
CAPACITORS					
C1	0.1	±10%	400V	Metallised film	Wima Tropyfol M
C2	2-5p			P.T.F.E.	Oxley TU/5/T
C3	3-10p			Ceramic	Steatite 10S Triko No. 33
C4	390p	±10%		Button	Erie 654-006
C5	2-12p			P.T.F.E.	Oxley TU/12/T
C6	3-10p			Ceramic	Steatite 10S Triko No. 33
C7	2-12p			P.T.F.E.	Oxley TU/12/T
C8	3-10p			Ceramic	Steatite 10S Triko No. 33
C9	2-5p			P.T.F.E.	Oxley TU/5/T
C10	3-10p			Ceramic	Steatite 10S Triko No. 33
C11	2-5p			P.T.F.E.	Oxley TU/5/T
C12	3-10p			Ceramic	Steatite 10S Triko No. 33
C13	2-5p			P.T.F.E.	Oxley TU/5/T
C14	3-10p			Ceramic	Steatite 10S Triko No. 33
C15	100p	±10%	125V	Polystyrene film	Wima Tropyfol F
C16, C17	.01	±20%	250V	Min. Met. foil	Mullard C280AE/P10K
C18	0.1	±10%	400V	Metallised film	Wima Tropyfol M
C19	2-5p			P.T.F.E.	Oxley TU/5/T
C20	3-10p			Ceramic	Steatite 10S Triko No. 33
C21	390p			Button	Erie 654-006

Circuit Ref.	Value	Tol.	Rating	Type	Style
C22	2-12p			P.T.F.E.	Oxley TU/12/T
C23	3-10p			Ceramic	Steatite 10S Triko No. 33
C24	2-12p			P.T.F.E.	Oxley TU/12/T
C25	3-10p			Ceramic	Steatite 10S Triko No. 33
C26	2-5p			P.T.F.E.	Oxley TU/5/T
C27	3-10p			Ceramic	Steatite 10S Triko No. 33
C28	2-5p			P.T.F.E.	Oxley TU/5/T
C29	3-10p			Ceramic	Steatite 10S Triko No. 33
C30, C31	22p	±2%	350V	Ceramic	Lemco MS611/1/R/22p
C32	2-5p			P.T.F.E.	Oxley TU/5/T
C33	3-10p			Ceramic	Steatite 10S Triko No. 33
C34	100p	±10%	125V	Polystyrene film	Wima Tropyfol F
C35, 36	22p	±10%	750V	Ceramic	Lemco CT310 NPO/1/R/22p
C37, C38	10p	±10%	750V	Ceramic	Lemco CT310 NPO/1/R/10p
C39, C40	6.8p	±10%	750V	Ceramic	Lemco CT310 NPO/1/R/6p8
C41, C42	10p	±10%	750V	Ceramic	Lemco CT310 NPO/1/R/10p
C43, C44	22p	±10%	750V	Ceramic	Lemco CT210 NPO/1/R/22p
C45	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K

MISCELLANEOUS

DL1	Delay Line Assembly		Dynamco B103 0459
L1, L2	Inductor		Dynamco A108 0242
PLC, PLD	Plug, fixed, 12-pole		McMurdo XP12
SA, SB	Switch, rotary, 4P11W	NSF Type 'A'	Dynamco B108 0206
SC	Switch, rotary, 1P5W	NSF Type 'A')	Dynamco B108 0208
SD	Switch, rotary, 2P2W (mounted concentrically with SC)	NSF Type 'A')	
SF, SG	Switch, miniature, Lever 1P3W	NSF Type MLA	Dynamco A108 0224
SKT1) SKT2)	Socket, fixed, co-axial BNC		Greenpar GE 35066
SKT3, SKT4	Socket, fixed, 2mm		Belling & Lee L1413
	Ferrite beads		Mullard FX 1115

6.3 MAIN AMPLIFIER BOARD

NOTE: All components on this board are prefixed "1" on the circuit diagram (Fig. 8).

Complete printed circuit board assembly — Dynamco PC105 0188/3

Circuit Ref.	Value	Tol.	Rating	Type	Style
RESISTORS					
R1	47	±10%	¼W	Composition	Dubilier B.T.T.
R2	1.8K	±2%	¼W	Composition	LCA 0309
R3	2.7K	±2%	¼W	Composition	LCA 0309
R4	47	±10%	¼W	Composition	Dubilier B.T.T.
R5	100	±2%	¼W	Composition	LCA 0309
R6	15K	±2%	¼W	Composition	LCA 0309
R7	47	±10%	¼W	Composition	Dubilier B.T.T.
R8	1K	±2%	¼W	Composition	LCA 0309
R9	2.2K	±2%	¼W	Composition	LCA 0309
R10	150	±2%	¼W	Composition	LCA 0309
R11	10K	±2%	¼W	Composition	LCA 0309
R12	1K	±2%	¼W	Composition	LCA 0309
R13	100K	±2%	¼W	Composition	LCA 0309
R14	4.7K	±2%	¼W	Composition	LCA 0309
R15 to R17	10	±10%	¼W	Composition	Dubilier B.T.T.
R18	10K	±2%	¼W	Composition	LCA 0309
R19	100K	±2%	¼W	Composition	LCA 0309
R20	10	±10%	¼W	Composition	Dubilier B.T.T.
R21	47	±10%	¼W	Composition	Dubilier B.T.T.
R22, R23	4.7K	±2%	¼W	Composition	LCA 0309
R24	47	±2%	¼W	Composition	LCA 0309
R25	1.8K	±2%	¼W	Composition	LCA 0309
R26	2.7K	±2%	¼W	Composition	LCA 0309
R27	47	±10%	¼W	Composition	Dubilier B.T.T.
R28, R29	47	±2%	¼W	Composition	LCA 0309
R30	180	±2%	¼W	Composition	LCA 0309
R31	120	±2%	¼W	Composition	LCA 0309
R32, R33	270	±2%	¼W	Composition	LCA 0309
R34	68	±2%	¼W	Composition	LCA 0309
R35, R36	1.5K	±2%	¼W	Composition	LCA 0309
R37, R38	47	±10%	¼W	Composition	Dubilier B.T.T.
R39, R40	47	±2%	¼W	Composition	LCA 0309
R41	220	±2%	¼W	Composition	LCA 0309
R42	120	±2%	¼W	Composition	LCA 0309
R43, R44	270	±2%	¼W	Composition	LCA 0309
R45	47	±10%	¼W	Composition	Dubilier B.T.T.
R46	68	±2%	¼W	Composition	LCA 0309
R47	47	±10%	¼W	Composition	Dubilier B.T.T.
R48, R49	1.5K	±2%	¼W	Composition	LCA 0309
R50	150K	±2%	¼W	Composition	LCA 0309
R51	3.3K	±2%	¼W	Composition	LCA 0309
R52, R53	470	±2%	¼W	Composition	LCA 0309
R54	390	±2%	¼W	Composition	LCA 0309
R55	2.2K	±2%	¼W	Composition	LCA 0309
R56	470	±2%	¼W	Composition	LCA 0309
R57, R58	4.7K	±2%	¼W	Composition	LCA 0309

Circuit Ref.	Value	Tol.	Rating	Type	Style
R59	470	±2%	¼W	Composition	LCA 0309
R60, R61	3.9K	±2%	¼W	Composition	LCA 0309
R62, R63	2.2K	±2%	¼W	Composition	LCA 0309
R64	1.8K	±2%	¼W	Composition	LCA 0309
R65	10	±10%	¼W	Composition	Dubilier B.T.T.
R66	33	±10%	¼W	Composition	Dubilier B.T.T.
R67	1.8K	±2%	¼W	Composition	LCA 0309
R68	33	±10%	¼W	Composition	Dubilier B.T.T.
R69	820	±2%	¼W	Composition	LCA 0309
R70	10	±10%	¼W	Composition	Dubilier B.T.T.
R71	820	±2%	¼W	Composition	LCA 0309
R72, R73	330	±2%	¼W	Composition	LCA 0309
R74	3.3K	±2%	¼W	Composition	LCA 0309
R75, R76	330	±2%	¼W	Composition	LCA 0309
R77	3.3K	±2%	¼W	Composition	LCA 0309
R78	330	±2%	¼W	Composition	LCA 0309
R79	10	±10%	¼W	Composition	Dubilier B.T.T.
R80	91	±2%	¼W	Composition	LCA 0309
R81	100	±2%	¼W	Composition	LCA 0309
R82	56	±2%	¼W	Composition	LCA 0309
R83	18	±2%	¼W	Composition	LCA 0309
R84, R85	2.2K	±2%	¼W	Composition	LCA 0309
R86, R87	100	±2%	¼W	Composition	LCA 0309
R88	18	±2%	¼W	Composition	LCA 0309
R89	2.7K	±2%	¼W	Composition	LCA 0309
R90	10	±10%	¼W	Composition	Dubilier B,T.T.
R91	470	±2%	¼W	Composition	LCA 0309
R92	2.7K	±2%	¼W	Composition	LCA 0309
R93	1K	±2%	¼W	Composition	LCA 0309
R94, R95	270	±10%	¼W	Composition	Dubilier B.T.T.
R96, R97	2.7K	±2%	¼W	Composition	LCA 0309
R98, R99	270	±10%	¼W	Composition	Dubilier B.T.T.
R100	2.7K	±2%	¼W	Composition	LCA 0309
R101 to R103	6.8K	±2%	¼W	Composition	LCA 0309
R104, R105	100	±2%	¼W	Composition	LCA 0309
R106	15K	±2%	¼W	Composition	LCA 0309
R107, R108	5.6K	±2%	¼W	Composition	LCA 0309
R109	820	±2%	¼W	Composition	LCA 0309
R110	1M	±10%	¼W	Composition	Dubilier B.T.T.
R111, R112	8.2K	±2%	¼W	Composition	LCA 0309
R113	820	±2%	¼W	Composition	LCA 0309
R114	270	±2%	¼W	Composition	LCA 0309

VARIABLE RESISTORS

RV1	250	Linear	Davall 80P
RV2, RV3	25K	Linear	Davall 80P

Circuit Ref.	Value	Tol.	Rating	Type	Style
RV4	100			Linear	Davall 80P
RV5, RV6	500			Linear	Davall 80P
RV7, RV8	10K			Linear	Davall 80P
RV9	250			Linear	Davall 80P
RV10	2.5K			Linear	Davall 80P
RV11	500			Linear	Morganite 62V

CAPACITORS

C1	1		250V	Metallised film	Wima MKS
C2	400		4V	Electrolytic	Mullard C426/AR
C3	20		64V	Electrolytic	Mullard C426/AR
C4	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K
C5	20		64V	Electrolytic	Mullard C426/AR
C6, C7	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K
C9	1		250V	Metallised film	Wima MKS
C10, C11	2-60p			Foil, trimmer	Mullard C010AA/60E
C12	20		64V	Electrolytic	Mullard C426/AR
C13	220p	±10%	160V	Film & foil	Wima Tropyfol F
C14, C15	47p	±10%	750V	Ceramic	Lemco CT316 NPO/1/ R47P
C16	.022	±20%	250V	Min. Met. paper	Mullard C280AE/P22K
C17, C18	1000p	±10%	160V	Film & foil	Wima Tropyfol F
C19	7-35p			Ceramic, trimmer	Steatite 7S Triko 02
C20	Select on test		160V	Film & foil	Wima Tropyfol F
C21	.01	±2%	160V	Film & foil	Wima Tropyfol F
C22, C23	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K
C24, C25	6800p	±5%	160V	Film & foil	Wima Tropyfol F
C26, C27	20		16V	Electrolytic	Mullard C426/AR
C28	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K
C29	20		64V	Electrolytic	Mullard C426/AR
C30, C31	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K
C32, C33	680p	±10%	750V	Ceramic	Lemco MS611/1/R/680P
C34, C36	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K
C37	.047	±20%	250V	Min. Met. paper	Mullard C280AE/P47K
C38	47p	±10%	750V	Ceramic	Lemco CT316NPO/1/ R47P
C40	20		16V	Electrolytic	Mullard C426/AR
C41, C42	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K
C43	Not used				
C44	820p	±5%	160V	Film & foil	Wima Tropyfol F
C45, C46	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K

VALVES

V1, V2	Nuvistor	RCA 7895

Circuit Ref.	Value	Tol.	Rating	Type	Style
TRANSISTORS					
VT1 to VT3					DMS 95
VT4, VT5					DMS 84
VT6, VT7					DMS 93
VT8, VT9					DMS 95
VT10, VT11					DMS 84
VT12, VT13					DMS 93
VT14					DMS 104
VT15, VT16					DMS 84
VT17					DMS 95
VT18					DMS 81
VT19, VT20					DMS 85
VT21, VT22					DMS 93
VT23 to VT26					DMS 95
DIODES					
D1 to D17					DMS 92
MISCELLANEOUS					
LP1, LP2	Neon	Hivac 29L or NT2			
SA	Switch, toggle				Waycom MST 105D
SB	Switch, toggle				Waycom MST 205N
	Transistor socket				Elco 05-3303
	Nuvistor socket				Cinch 91/001

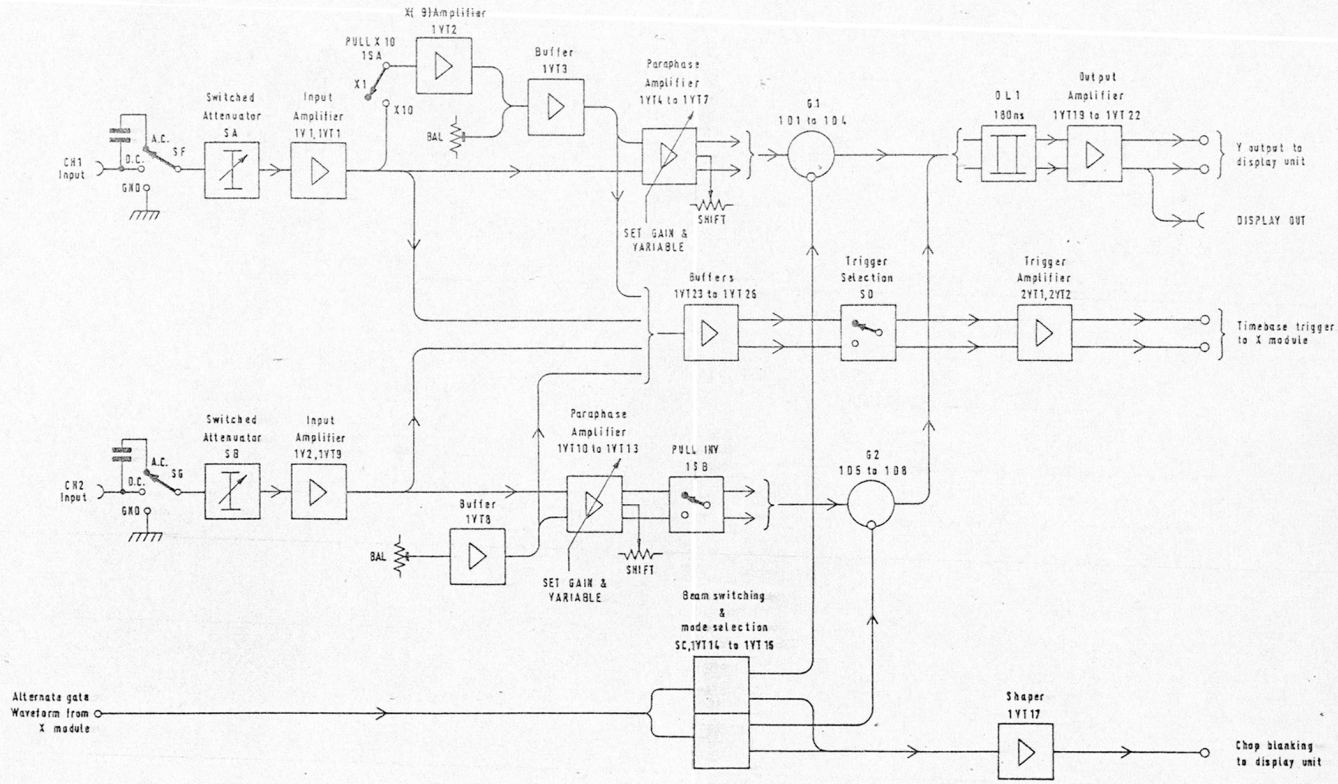
6.4 TRIGGER BOARD

NOTE: All components on this board are prefixed "2" on the circuit diagram (Fig. 8).

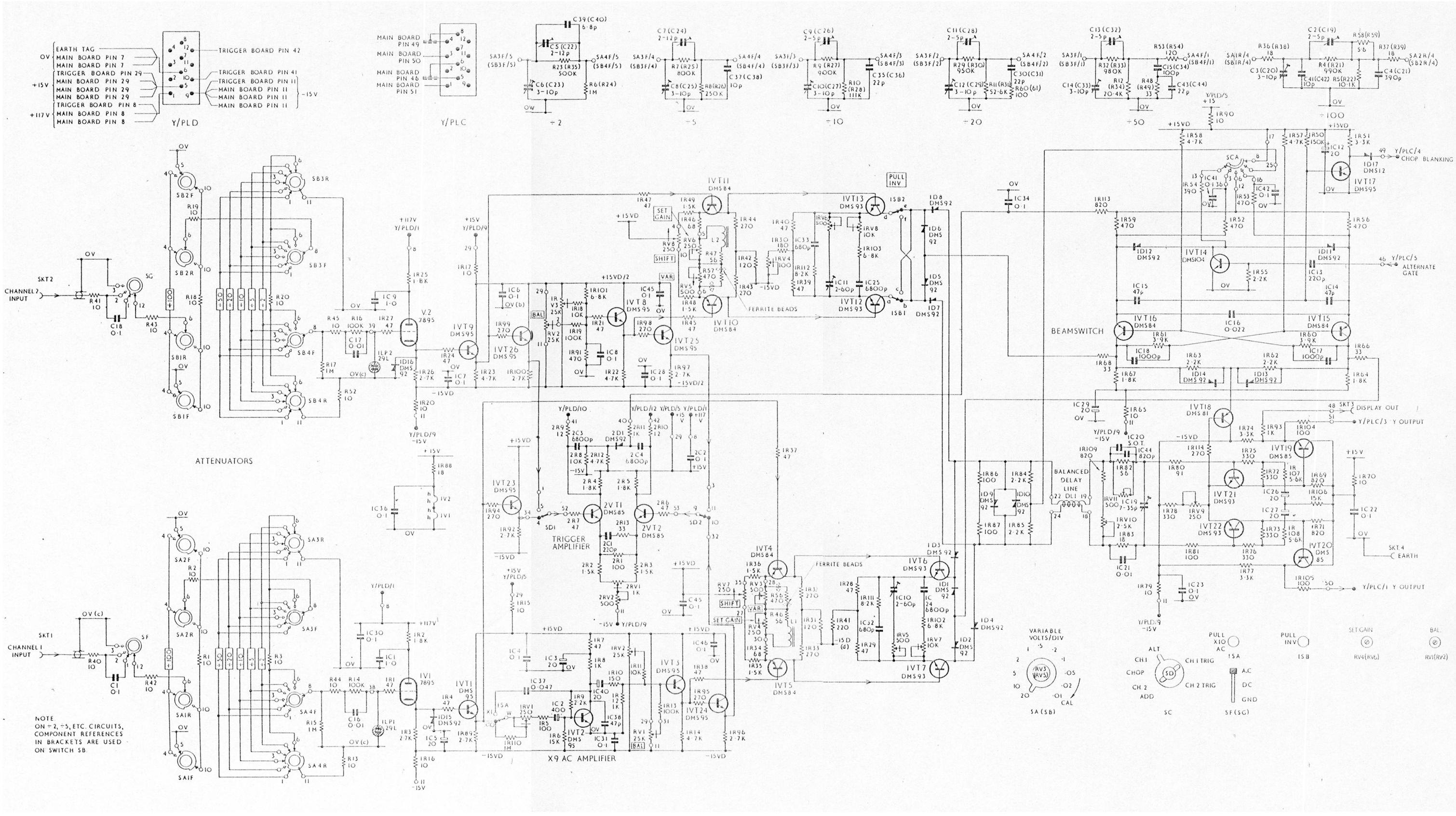
Complete printed circuit board assembly — Dynamco PC105 0189/3

RESISTORS					
R1	100	±2%	¼W	Composition	LCA 0309
R2, R3	1.5K	±2%	¼W	Composition	LCA 0309
R4, R5	1.8K	±2%	¼W	Composition	LCA 0309
R6, R7	47	±10%	¼W	Composition	Dubilier B.T.T.
R8	10K	±2%	¼W	Composition	LCA 0309
R9, R10	12	±10%	¼W	Composition	Dubilier B.T.T.
R11	1K	±2%	¼W	Composition	LCA 0309
R12	4.7K	±2%	¼W	Composition	LCA 0309

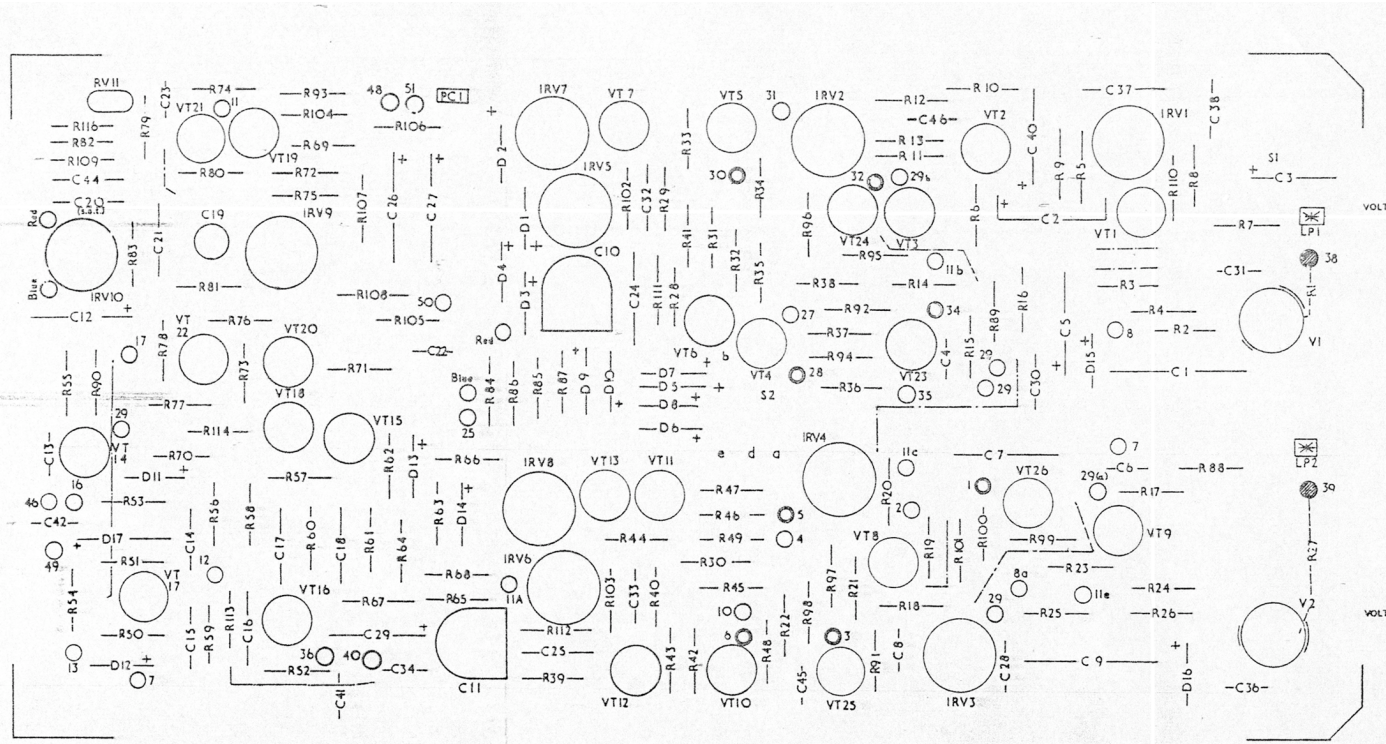
Circuit Ref.	Value	Tol.	Rating	Type	Style
R13	33	±10%	$\frac{1}{4}$W	Composition	Dubilier B.T.T.
VARIABLE RESISTORS					
RV1	1K			Linear	Davall 80P
RV2	500			Linear	Davall 80P
CAPACITORS					
C1	220p	±10%	160V	Film & foil	Wima Tropyfol F
C2	0.1	±20%	250V	Min. Met. paper	Mullard C280AE/P100K
C3, C4	6800p	±5%	160V	Film & foil	Wima Tropyfol F
DIODE					
D1					DMS 92
TRANSISTORS					
VT1, VT2					DMS 85
MISCELLANEOUS					
	Transistor sockets				Elco 05-3303



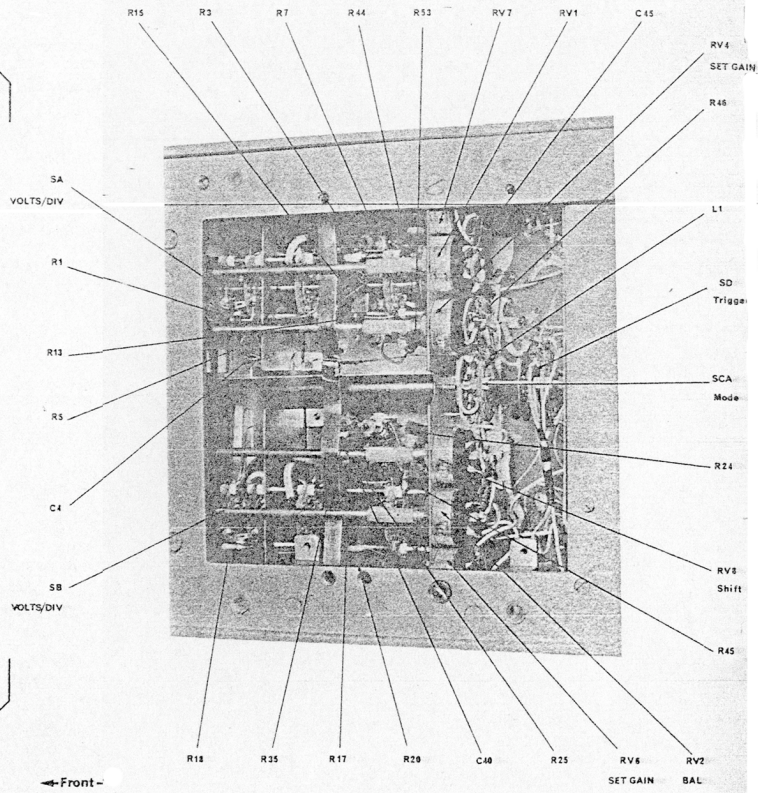
BLOCK DIAGRAM FIG.5



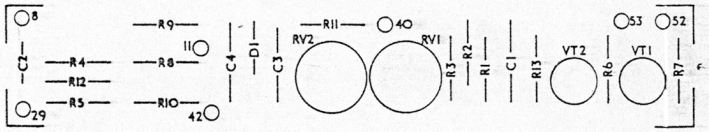
DUAL CHANNEL AMPLIFIER - CIRCUIT FIG.8



Y AMPLIFIER LAYOUT

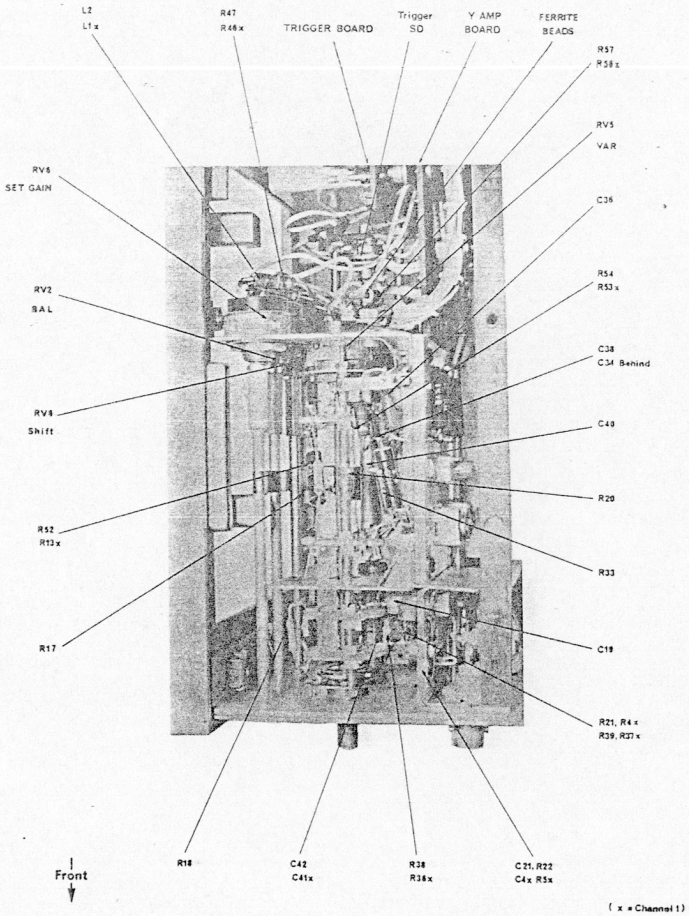


CHASSIS LAYOUT–RIGHT SIDE

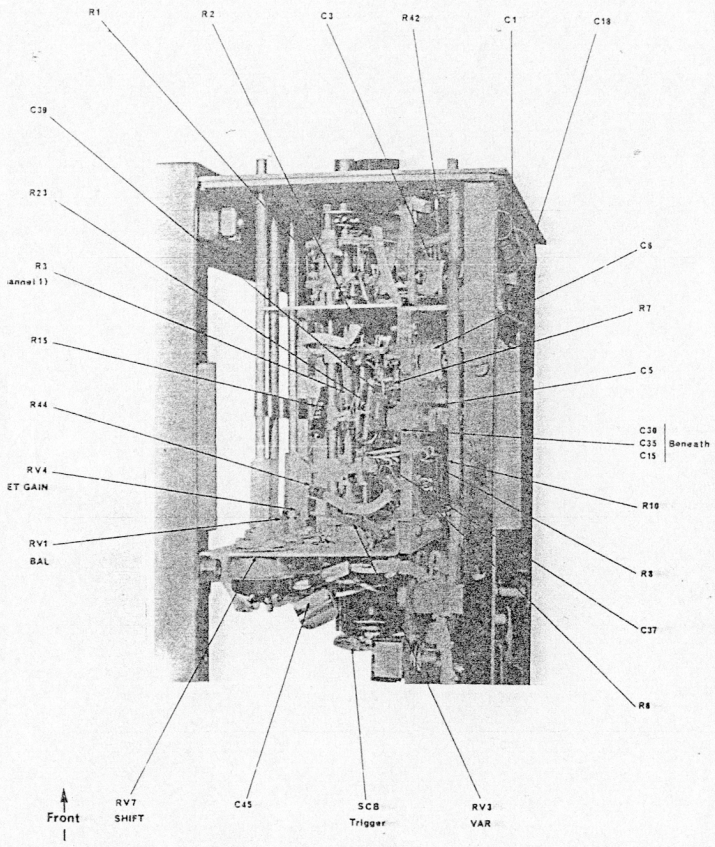


TRIGGER BOARD LAYOUT

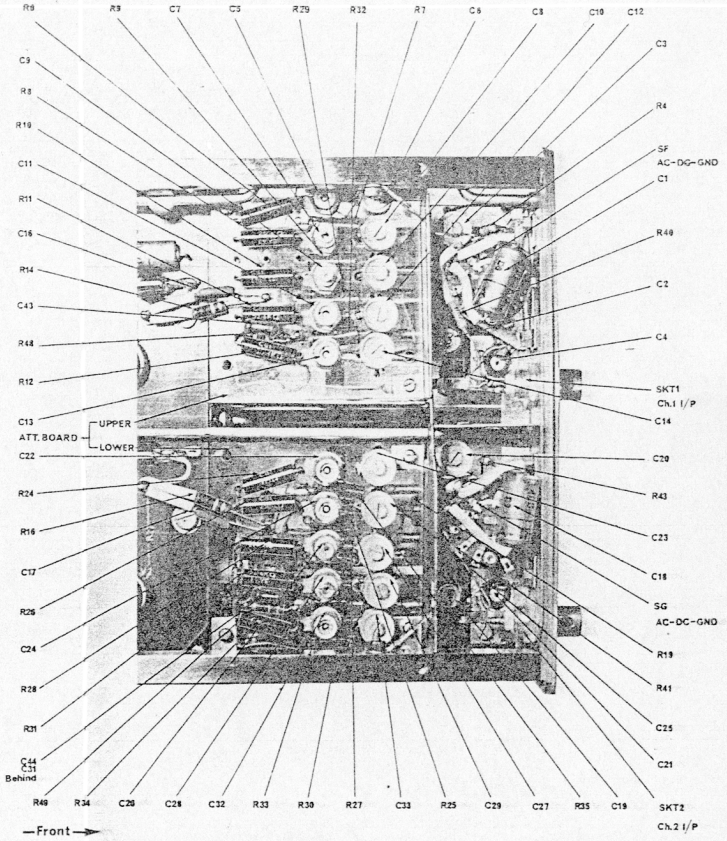
FIG.9 COMPONENT LOCATION



CHASSIS LAYOUT - UNDER VIEW



CHASSIS LAYOUT-TOP VIEW



CHASSIS LAYOUT-LEFT SIDE

COMPONENT LOCATION FIG.10